Volume 1, Number 4

4th Quarter, 2008

The State of the Internet

The "spinning globe" featured in the Akamai NOCC represents where Akamai servers are located and how much traffic they are seeing.

Executive Summary

Each quarter, Akamai will be publishing a quarterly "State of the Internet" report. This report will include data gathered from across Akamai's global server network about attack traffic and broadband adoption, as well as trends seen in this data over time. It will also aggregate publicly available news and information about notable events seen throughout the quarter, including Denial of Service attacks, Web site hacks, and network events, including outages and new connections.

During the fourth quarter of 2008, Akamai observed attack traffic originating from 193 unique countries around the world. The United States and China were the two largest attack traffic sources, accounting for over 42% of observed traffic in total. Akamai observed attack traffic targeted at more than 20,000 unique ports, with the top 10 ports seeing over 77% of the observed attack traffic. Web site hacks and Web-based exploits were regularly in the news during the quarter, as was a proof-of-concept exploit for a vulnerability in SSL, the underlying mechanism that secures financial and retail transactions, among others, across the Web.

Notable network outages in the fourth quarter were due to submarine cables in the Mediterranean being severed, as well as two major Internet backbone providers de-peering their networks from one another. Notable Web site outages in the fourth quarter were attributed to increased traffic, hardware failure, and power outages.

Global connectivity advanced in the fourth quarter, with the commercial launch or announcement of WiMAX and 3G broadband services in a number of countries, the launch of higher speed cable broadband services based on DOCSIS 3.0, and additional fiber-to-the-home services that will bring extremely high-speed connections to subscribers in Switzerland, Brazil, India, Spain, Italy, and Russia.

Akamai observed a nearly six percent increase (from the third quarter 2008) globally in the number of unique IP addresses connecting to Akamai's network, and a 28% increase from the end of 2007. From a global connection speed perspective, South Korea had the highest levels of "high broadband" (>5 Mbps) connectivity for the fourth consecutive quarter, and the highest average connection speed, at 15 Mbps. In the United States, Delaware also maintained its top position, with 62% of connections to Akamai occurring at 5 Mbps or greater, and the highest average connection speed in the United States, at 7.3 Mbps. Looking at observed "narrowband" (<256 Kbps) connections, Mayotte and Equatorial Guinea were the "slowest" countries, with 98% and 96% of connections to Akamai, respectively, occurring at speeds below 256 Kbps. In the United States, the District of Columbia continued to have the highest percentage of observed connections below 256 Kbps. However, this was down nearly seven percent from the prior quarter, and over 42% from the end of 2007.

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Introduction

Akamai's globally distributed network of servers allows us to gather massive amounts of information on many metrics, including connection speeds, attack traffic, and network connectivity/availability/latency problems, as well as user behavior and traffic patterns on leading Web sites.

In the fourth quarter of 2008, observed distributed denial of service (DDoS) attack traffic continued to target a consistent set of ports, though it appears that some are now being targeted by a new set of network worms. In addition, it appears that spikes in attack traffic may be correlated with patch releases or security advisories issued by Microsoft, as hackers rush to exploit vulnerabilities before system administrators can apply software patches.

Two large-scale network outages occurred during the quarter, as undersea cables were once again severed in the Mediterranean, and as Sprint-Nextel de-peered their network from Cogent Communications. However, global connectivity continued to become more robust, with new WiMAX and 3G mobile broadband services being announced or launching in a number of countries, and the introduction of DOCSIS 3.0 services and additional fiber-to-the-home initiatives, which are bringing higher speed connectivity to subscribers in multiple countries.

In the fourth quarter, six countries connected to Akamai's network at average speeds in excess of 5 Mbps, and for the year, many countries showed significant increases in their levels of high broadband (>5 Mbps) adoption. Decreases in the percentage of narrowband (<256 Kbps) connections to Akamai were also seen both internationally and in the United States, likely due, in part, to the growth in availability of, and options for, broadband connectivity.

Section 2: Security

Akamai maintains a distributed set of agents deployed across the Internet that serve to monitor attack traffic. Based on the data collected by these agents, Akamai is able to identify the top countries from which attack traffic originates, as well as the top ports targeted by these attacks. (Ports are network layer protocol identifiers.) This section, in part, provides insight into Internet attack traffic, as observed and measured by Akamai, during the fourth quarter of 2008. While some quarter-over-quarter trending may be discussed, it is expected that both the top countries and top ports will change on a quarterly basis.

This section also includes information on selected DDoS attacks, Web site hacking attempts, Web-based exploits, and other attacks and events as published in the media during the fourth quarter of 2008. Note that Akamai does not release information on attacks on specific customer sites and that selected published reports are simply compiled here.

2.1 Attack Traffic, Top Originating Countries

During the fourth quarter of 2008, Akamai observed attack traffic originating from 193 unique countries around the world, up nearly 8% from the third quarter count of 179 countries. This quarter, the United States moved into the first place slot for the first time in 2008, after placing second to China or Japan throughout the year. Argentina returned to the top 10 again in the fourth quarter — it was ranked fifth for first quarter attack traffic. Throughout 2008, the United States, China, Taiwan, South Korea, and Japan were consistently among the top 10 countries that generated the highest percentages of attack traffic.

The trend in attack traffic distribution continues to be relatively consistent with the prior quarters, with the top 10 countries as the source for just under 72% of observed attack traffic. (This is down slightly from prior quarters, where the top 10 countries accounted for 74-78% of observed attack traffic.) The list of countries within the top 10 appears to be getting more consistent, as observed across 2008 — the five countries listed above appeared in the list during all four quarters, while Russia, Germany, and Brazil each held spots in the top 10 during three of the four quarters in 2008.

	Country	% Traffic	Q3 08 %
1	United States	22.85	19.68
2	China	19.30	26.85
3	Sweden	10.67	3.86
4	Taiwan	5.61	2.54
5	South Korea	2.52	9.37
6	Argentina	2.51	0.39
7	Russia	2.33	1.94
8	Germany	2.15	2.20
9	Japan	2.00	3.13
10	Brazil	1.68	2.64
–	OTHER	28.38	–

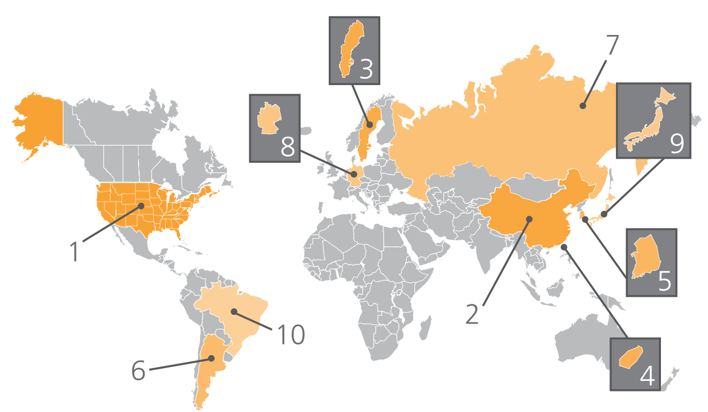

Figure 1: Attack Traffic, Top Originating Countries

In December, IT security firm Sophos published[1] its *Security Threat Report 2009*, which examined the security threat landscape over the course of 2008. The report noted that the top 5 malware-hosting countries in 2008 consisted of the United States, China (including Hong Kong), Russia, Germany, and South Korea. It is interesting to note that these countries have also all consistently been among the top 10 countries from which Akamai has observed attack traffic originating in during 2008.

2.2 Attack Traffic, Top Target Ports

During the fourth quarter of 2008, Akamai observed attack traffic targeted at just over 20,800 unique ports, over eight times more than in the third quarter. Consistent with prior quarters, some of the attack traffic targeted services on well-known ports. Due to the significant growth in port count, the attack traffic was slightly less concentrated than in prior quarters, with the top 10 ports responsible for only 77% of the observed attack traffic. (This is down from an 85% or greater concentration during prior quarters of 2008.) While it is unclear exactly what is accounting for the growth in targeted port count, data from fourth quarter monitoring shows that the United States is clearly responsible for this growth during the quarter, with originating attack traffic destined for over 20,200 unique ports. Obviously, there is a significant "long tail" that occurs – the top 200 target ports only account for 73% of the observed attack traffic from the United States.

For the third consecutive quarter, Port 445 (Microsoft-DS) held the first place spot, with a slightly higher percentage of the overall observed traffic than in the third quarter, and still below second quarter levels. This port represented over half of the attack traffic observed from Argentina in the fourth quarter, approximately a quarter of the attack traffic from the United States and Russia, and around a third of observed attack traffic coming from Taiwan, Japan, Brazil, and Germany. While this port was previously associated with the Sasser worm, it appears that it is also[2] associated with the Gimmiv.A worm, which exploited a vulnerability[3] that was considered to be significant enough to ultimately be addressed by Microsoft in a patch[4] released outside of their normal "Patch Tuesday" cycle. The Conficker worm is reported to also be using Port 445 and exploiting this same vulnerability to spread across the Internet. The Conficker worm will be covered in more detail in Akamai's *1st Quarter, 2009 State of the Internet* report.

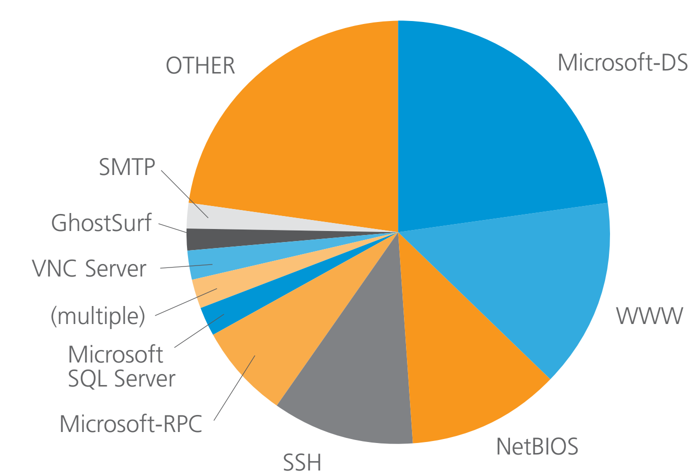

Figure 2: Attack Traffic, Top Target Ports

Destination Port	Port Use	% Traffic	Q3 08 %
445	Microsoft-DS	22.96	21.12
80	WWW	14.51	9.18
139	NetBIOS	11.56	21.09
22	SSH	10.78	9.73
135	Microsoft-RPC	7.15	10.68
1433	Microsoft SQL Server	2.46	3.20
8000	(multiple)	2.14	0.87
5900	VNC Server	2.07	1.93
7212	GhostSurf	1.93	0.74
25	SMTP	1.89	2.28
Various	OTHER	22.56	–

For the first time in 2008, Port 80 (WWW) moved into second place in the top 10. SQL injection attacks continued to be a popular attack vector in the fourth quarter, as noted in Section 2.5. The significant growth in observed attack traffic to this port may be due to scans looking for Web servers that are vulnerable to such attacks. Interestingly, Port 80 was responsible for over 93% of the attacks that were observed to be originating in Sweden.

Attacks targeted at Port 8000 also grew significantly in the fourth quarter, enough to push it into the top 10 list. Officially,[5] Port 8000 is used for the "iRDMI" service, though it is unclear what this service is, or what it is used for. However, the port is also[6] reportedly used by a number of other software packages, and is also often used as an alternative default port for HTTP traffic. It is not known which piece of software that binds to Port 8000 was targeted by these attacks.

Port 7212 also made its first appearance in the top 10 during the fourth quarter. During the third quarter, this port was the top target port for attacks seen from China — in the fourth quarter, it was the third most targeted port for China-sourced attacks. Please refer to Akamai's *3rd Quarter, 2008 State of the Internet* report for additional details on Port 7212 vulnerabilities.

2.3 Attack Traffic, By Day

After previous issues of Akamai's *State of the Internet* report were published, it was suggested that attack traffic patterns may have a correlation with Microsoft's "Patch Tuesday" updates — a so-called "Attack Wednesday" following the Tuesday release of patches by Microsoft, as attackers looked for unpatched systems in order to exploit those specific vulnerabilities. However, looking at observed attack traffic from the fourth quarter, aggregated by day of week, it does not appear that this suggested correlation necessarily holds, as is shown in Figure 3.

In fact, it appears that Wednesdays accounted for the lowest percentage of weekday traffic during the fourth quarter, though still ahead of the percentage of attacks that was observed on Saturdays and Sundays.

However, looking at attack traffic by day across the quarter, a significant increase occurred on November 19, and attack traffic remained elevated throughout the rest of the quarter, as shown in Figure 4.

It is interesting to note that November 19 is, in fact, a Wednesday, but did not follow a "Patch Tuesday" release — Microsoft Security Bulletins MS08-068[7] and MS08-069[8] were released a week prior. However, the

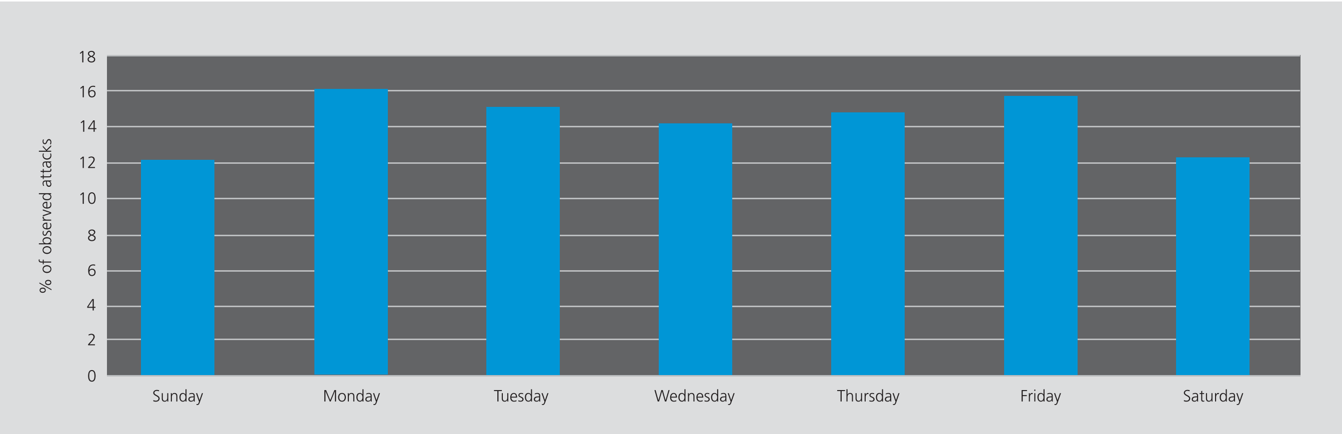

Figure 3: Attack Traffic, Aggregated by Day of Week

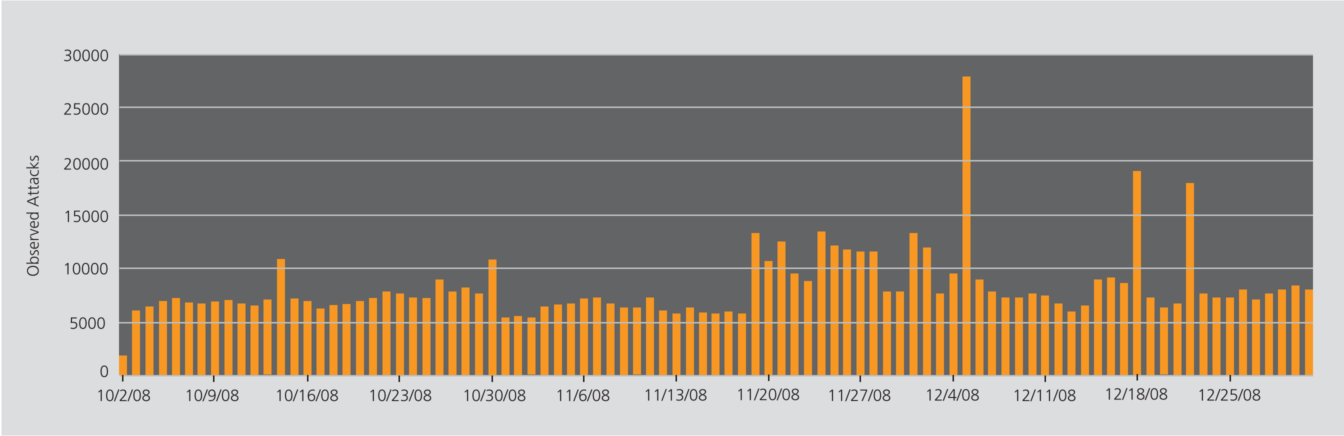

Figure 4: Attack Traffic, by Day of Quarter

peak seen on December 18 did follow an out-of-band update[9] issued by Microsoft that addressed a critical vulnerability in some versions of their Internet Explorer Web browser, and the near-doubling of attack traffic seen on that day may be related to that vulnerability. In addition, the massive spike that was seen on December 5 followed the posting of an "Advanced Notification"[10] by Microsoft of the security bulletins that were going to be released the following Tuesday. Again, this increase in attack traffic may have been related to attackers rushing to exploit the related vulnerabilities ahead of patches being issued. Finally, the spike seen on December 22 can likely be correlated with a security advisory issued that day[11] by Microsoft, warning that systems running various older versions of SQL Server were vulnerable to attack, and the traffic seen that day has a high likelihood of being attempted SQL injection attacks.

Comparing the levels of attack traffic targeted at the top three Microsoft-related ports (445, 139, and 135) aggregated across the fourth quarter, and charting the levels by day of week, they all appear to follow a similar pattern. The number of attacks reaches the highest levels early in the week, bottoming out on Thursday, and then increasing again into the weekend, as shown in Figure 5. This traffic pattern may also be influenced by Microsoft's

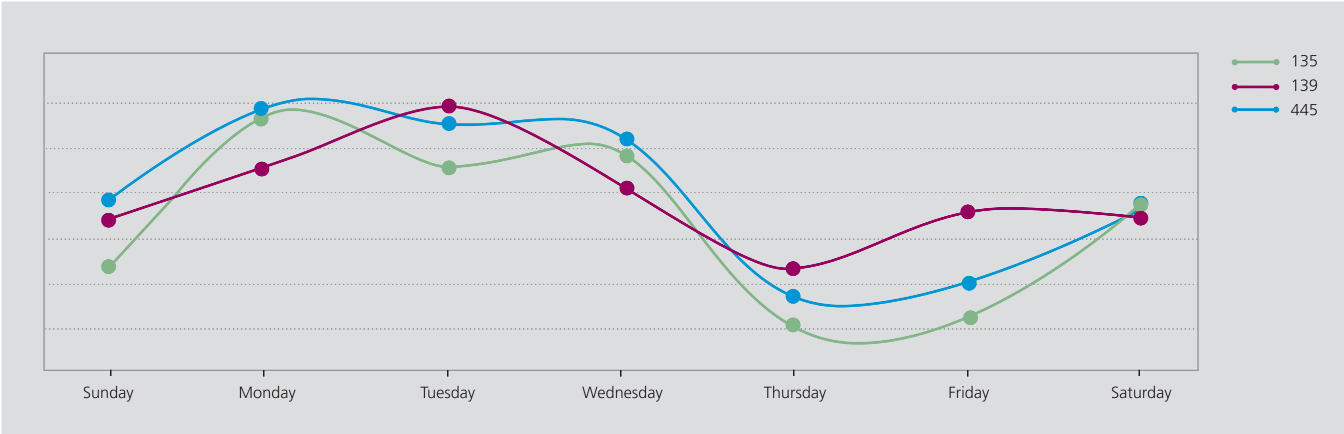

Figure 5: Attack Traffic Targeting Ports 445, 139, and 135 by Day of the Week

practice of releasing major patches on Tuesday — vulnerabilities are exploited ahead of the patch releases, and then as compromised systems are patched, attack volume decreases.

2.4 Distributed Denial of Service (DDoS) Attacks

The Internet celebrated an auspicious occasion on November 2, 2008, the 20th anniversary of the "Morris Worm", arguably the first major denial of service attack on the Internet. According to a published report,[12] the worm was written by then Cornell University student Robert Tappan Morris, who was later convicted of computer fraud for the incident. Morris is now an associate professor of computer science at MIT. Launched on November 2, 1988, the Morris worm disabled approximately 10% of all Internet-connected systems. The worm was a self-replicating program that exploited known weaknesses in common utilities including e-mail software sendmail, as well as Finger, a tool that showed which users were logged on to a given computer.

Several high-profile Web sites suffered DDoS attacks during the fourth quarter. The BBC Web site was subjected to a DDoS attack on November 6 that crippled the Web site's performance significantly. During the attack, the BBC Web site responded very slowly, and measurements made by monitoring service Pingdom showed that for a total of 1 hour and 15 minutes it did not respond at all.[13] The Web site for "NO on Prop 8" (opposing Proposition 8, which would eliminate same-sex couples' right to marry in California) was hit by a DDoS attack that took the site down for several hours on October 29, with attack traffic originating from computers not just within California, but also from Texas, New Jersey and Georgia.[14] The Wordpress.com blog platform (hosting more than 4.5 million blogs) was subjected to a DDoS attack on October 27 that caused some of its blogs to become unavailable for a period of time. Wordpress.com has three origin data centers and was able to reroute the relevant traffic to unaffected servers once the DDoS attack had been identified and isolated.[15]

2.5 Web Site Hacks & Web-Based Exploits

In December, the Koobface virus resurfaced on Facebook. The virus leverages malware unknowingly downloaded by users, which sends out messages to their Facebook friends, urging them to click on a link that takes them to an infected Web site,[16] as well as hijacking search requests made to popular search sites such as Google, Yahoo, and MSN.

As discussed in the previous two issues of the *State of the Internet* report, cross-site scripting (XSS) continues to be a problem. In October, Yahoo fixed an XSS error in the hotjobs.yahoo.com domain that allowed attackers to inject JavaScript code into the page that silently copied the cookies used to authenticate Yahoo users when they log in to sections of the site that require a password. Attackers, using these cookies, then had broad control over the victim's Yahoo account, including Yahoo e-mail and any other service that uses authentication cookies belonging to the yahoo.com domain.[17] In December, it was discovered that an XSS error on americanexpress.com allowed attackers to steal users' authentication cookies, which are used to validate American Express customers after they enter their login credentials.[18] However, the security hole was closed within an hour after an article about it was posted on IT news Web site The Register. Four XSS bugs on the Facebook Web site were also publicized and quickly addressed in December.[19]

SQL injection once again continued to be a popular vector for Web-based attacks during the fourth quarter. Two Adobe Web sites, Vlog It and Serious Magic, were compromised through SQL injection in October, according to Internet security firm Sophos.[20] In November, security firm Kaspersky Lab discovered 1,200 Web sites around the world that had been compromised by an SQL injection attack that appeared to originate from China.[21] In late December, Microsoft issued a warning[22] about a critical bug in its SQL server software that could be exploited by attackers.

As initially described in the *3rd Quarter, 2008 State of the Internet* report, the Web-based attack vector known as "clickjacking" gained additional exposure during the fourth quarter. In early October, an Israeli research released a proof-of-concept demo that highlighted the threat posed the clickjacking flaw.[23] Days later, Adobe posted[24] a workaround procedure to help mitigate exposure, and subsequently released a Flash Player update[25] that addressed the security vulnerabilities.

In October, a researcher at Aladdin Knowledge Systems announced that that he had discovered a cache of usernames and passwords for over 200,000 Web sites, including 80,000 that had been modified with malicious content.[26] According to the researcher, the 200,000 compromised sites included those belonging to governments, Fortune 500 companies, universities and other businesses; more than half of the affected sites belonged to European companies and organizations. Other Web sites hacked in the fourth quarter included those belonging to online bill payment company CheckFree,[27] the Ohio Secretary of State,[28] and the World Bank.[29]

2.6 TCP-Based Attacks

As noted above in Section 2.2, the Conficker worm exploits services running on TCP port 445, and was identified as a key component in a botnet that was estimated to include approximately half a million compromised systems by early December.[30] The Conficker worm will be covered in more detail in Akamai's *1st Quarter, 2009 State of the Internet* report.

2.7 McColo Shutdown

In mid-November, hosting provider McColo Corp. was disconnected from the Internet. Identified as a major host of organizations engaged in sending unsolicited e-mail ("spamming"), it was reported that McColo had been responsible for up to 75% of all spam sent each day.[31]

In addition to reducing spam volumes across the Internet, the disconnection of McColo also served to disrupt the "Rustock" and "Srizbi" botnets, crippling an estimated 500,000 compromised systems ("bots").[32] Although the Srizbi botnet control servers resurfaced at an ISP in Estonia, that ISP quickly cut off connectivity to those servers.[33] Unfortunately, the Srizbi bots gradually became active again through updates to their code, and it appeared that several weeks after the McColo shutdown that spam volumes were once again on the rise.[34]

2.8 SSL Vulnerability

On December 30, it was announced at the 25th Chaos Communication Congress that researchers had found a way to target a known weakness in the MD5 algorithm to create a rogue Certification Authority (CA) that would allow them to create "fake" SSL certificates that would still be fully trusted by all modern Web browsers.[35] As of the time of the announcement, at least six CAs were using the MD5 algorithm to sign SSL certificates, and the researchers estimated that 30-35% of all SSL certificates currently in use had an MD5 signature somewhere in their authentication chain.[36]

Because the digital signature on the fake certificate appears to come from a reputable and presumably trustworthy CA, a user's browser will accept it and indicate to the user that the connection is secure. Coupled with the DNS attack described by Dan Kaminsky, users could be redirected to malicious sites without being aware of it. These rogue e-commerce or banking sites, for example, would appear trusted, and could make the collection of login or other personal data fairly simple for an attacker without raising a user's suspicion.

Two days after the announcement, VeriSign announced that they would be transitioning from the MD5 algorithm to the SHA-1 algorithm for digital certificates they issued, and security researchers encouraged other CAs to do the same.[37]

2.9 DNSSEC

Following the DNS exploit described by Dan Kaminsky in the third quarter, and the subsequent push for the implementation of DNSSEC, the Internet Corporation for Assigned Names and Numbers (ICANN),[38] VeriSign,[39] and the United States Department of Commerce National Telecommunications and Information Administration (NTIA)[40] all issued proposals regarding the cryptographic signature of the DNS root zone. NTIA invited interested stakeholders to file comments on the proposals, and received more than 30 comments in favor of securing the root zone. Commenters included representatives of the Internet Architecture Board, the Internet Society, Akamai Technologies, NeuStar, Afilias, and Comcast.[41]

In the meantime, seven leading domain name vendors, representing more than 112 million domain names (65% of all registered domain names) formed the DNSSEC Industry Coalition to work together to drive the adoption of DNSSEC across all domain name registries and registrars around the world.[42] Participants in the coalition include VeriSign (.com, .net), The Public Interest Registry (.org), Nominet UK (.uk), Afilias (.info), NeuStar (.biz, .us), the Foundation for Internet Infrastructure (.se), and Educause (.edu). While the primary goal of the coalition is to accelerate the deployment of DNSSEC, the participants noted that it would be "unrealistic" to set forth a timetable for deployment until the issues surrounding signature of the DNS root zone are resolved.

Section 3: Networks and Web Sites: Issues & Improvements

The fourth quarter of 2008 saw another significant network outage in the Mediterranean, as a result of three undersea cables being severed. A peering dispute between Sprint-Nextel and Cogent Communications effectively partitioned the Internet, preventing single-homed customers of both providers from reaching one another. In addition, a number of high profile Web sites experienced availability problems throughout the quarter due to a variety of reasons, including power outages and flash crowds. Many new WiMAX initiatives were announced, which are likely to bring wireless broadband connectivity to users in countries around the world, and new fiber-to-the-home initiatives and DOCSIS 3.0 rollouts brought extremely high-speed wired broadband connectivity to users in North and South America, Asia, and Europe.

3.1 Network Outages

On December 4, equipment failure caused a complete loss of Internet connectivity for two of the three ISPs in Haiti that connect to the Internet through the ARCOS submarine cable. The outage lasted for approximately three-and-a-half hours until traffic was re-routed through an alternate submarine cable through Puerto Rico.[43] On December 8, over a million subscribers of Time Warner Cable saw their Internet connectivity impaired for approximately two-and-a-half hours due to the failure of Time Warner's DNS servers.[44]

Eerily echoing events of January 2008, on the morning of December 19, three key underwater cables in the Mediterranean (SeaMeWe-3, SeaMeWe-4 and FLAG) were severed, which impacted Internet traffic in the Middle East and the Indian subcontinent.[45] According to measurements from Renesys, more than 1,400 of Egypt's and more than 450 of India's globally routed prefixes (networks) suffered outages, as shown in Figure 6. Repairs to the SeaMeWe-3 and SeaMeWe-4 cables began two days later, as the repair ship "Raymond Croze" was dispatched by France Telecom.[46] Unfortunately, as France Telecom finished repairing the SeaMeWe-4 cable on December 25, the cable broke again in a different place, which pushed out repairs until approximately 10 days later than originally expected.[47]

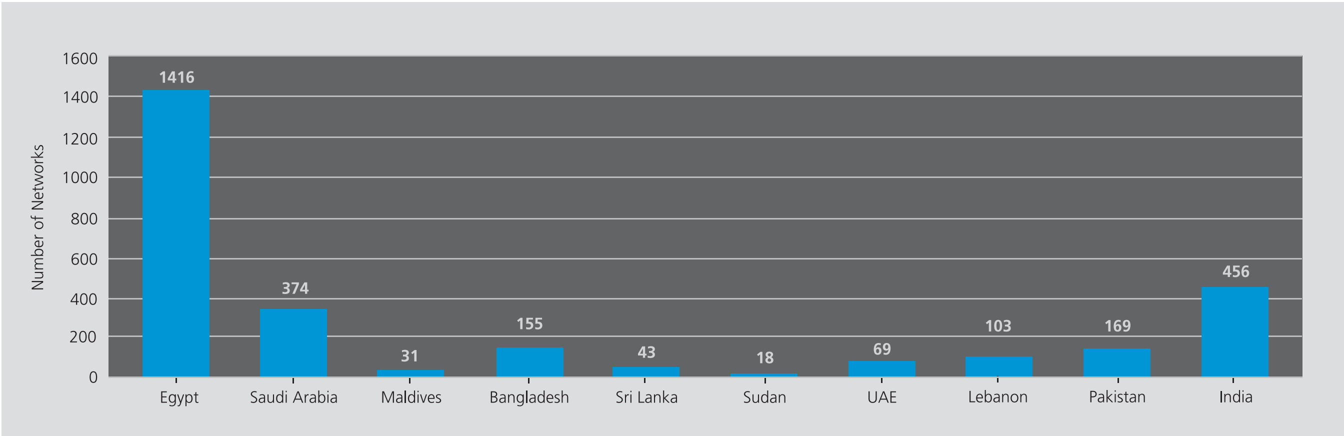

Figure 6: Network Outages by Country (Data courtesy of Renesys)

A Reuters article[48] noted that the three severed cables were the most direct route for moving traffic between Western Europe and the Middle East, and that Verizon had rerouted some of its traffic by sending it across the Atlantic, then the United States, across the Pacific, and on to the Middle East. It is important to note that Akamai's services can help customers maintain consistent site and application performance and availability when such cable cuts occur, and when alternate routes force traffic across continents and oceans. Figure 7 illustrates the results of a performance test for a customer portal hosted in Europe, as seen by Akamai's AsiaPac measurement agents. As shown, the measurement agents saw a significant degradation in performance when trying to retrieve content from the origin during the two days before repairs began. However, portal performance as delivered by Akamai's IP Application Accelerator service remained consistent throughout the duration of the cable cut, as Akamai is able to identify and send traffic over alternative network paths on a real-time basis.

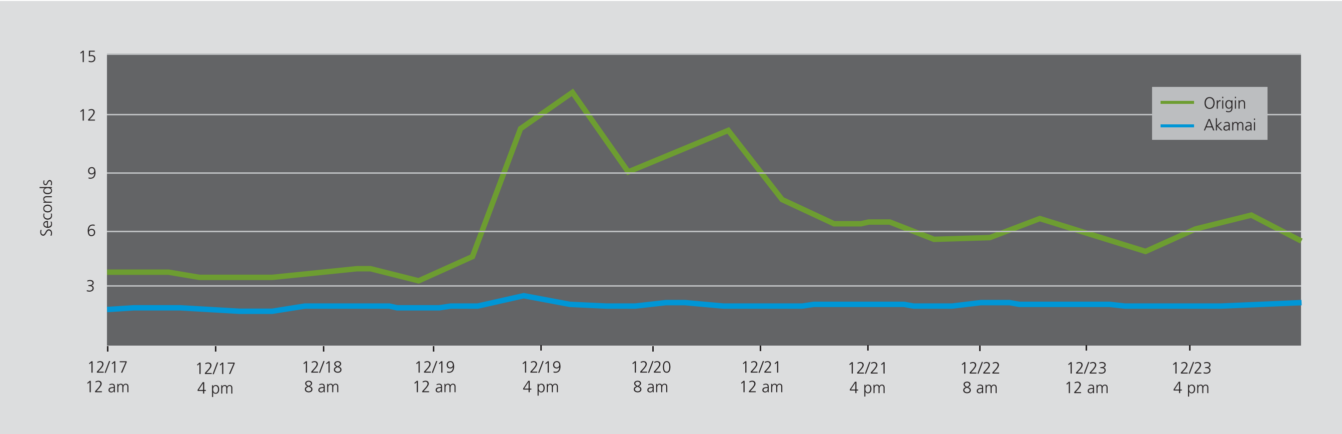

Figure 7: Akamai Download Performance Remained Consistent Despite Cable Cut

3.2 Routing Issues

On November 10, Companhia de Telecomunicacoes do Brasil Central (CTBC) inadvertently leaked a nearly-full set of routing information to two of its upstream network providers, in essence hijacking most of the Internet's address space. The data was not generally propagated to the Internet at large, though, preventing another YouTube-like issue that occurred earlier in the year. (See Section 3.3 of Akamai's *1st Quarter, 2008 State of the Internet* report for additional details on the YouTube issue.) Ultimately, the leak had no significant global impact. However, it did make its way to RIPE's route collector in Sao Paolo, Brazil, where a volunteer-based route monitoring project noticed the leaked announcement and notified subscribers via e-mail of the hijacking.[49] While there was little impact to the Internet as a whole, the event served to underscore the challenges that surround monitoring for, and alerting on, significant route changes.

3.3 Peering Issues

On October 30, the network link between Cogent and Sprint-Nextel disappeared; from a routing perspective — Sprint de-peered Cogent. As a result, customers of Cogent lost access to networks connected to Sprint, and vice-versa.[50] Cogent is no stranger to peering disputes, and had been involved in at least four prior incidents over the last six years — AOL in 2003, France Telecom in 2006, Level 3 in 2005 and TeliaSonera in March 2008.[51] A related post[52] on the Renesys blog noted that 289 autonomous systems (networks) are completely single-homed (have no connectivity to the Internet through anyone else) behind Cogent, and that 214 are completely single-homed behind Sprint. In addition, Renesys noted, due to Cogent's aggressive pricing, there are a large number of service providers that are multi-homed but that send all of their outbound traffic through Cogent by default. Consequently, this de-peering prevented traffic originating from those users from reaching Sprint-connected users. Unsurprisingly, Sprint PCS was one of the networks single-homed to Sprint's network, meaning that users of mobile devices using Sprint's cell phone services may have had problems connecting to Web sites and online services connected to Cogent.

Published reports[53] indicated that the peering dispute was sourced in a disagreement over payments that Sprint claimed it was owed for ongoing traffic exchange after a peering trial that ended in September 2007 — Cogent's executives believed that the results of the trial had qualified them for settlement-free peering. However, on November 2, Sprint re-enabled the connection with Cogent,[54] and on December 22, Sprint and Cogent announced that they had reached a multi-year interconnection agreement for the purposes of exchanging Internet traffic.[55]

3.4 Web Site Outages

The Web site of file sharing service Yousendit was unavailable for over 5 hours in total, due to four separate outages that occurred on November 17. The shortest outage lasted 30 minutes and the longest lasted 2 hours and 25 minutes.[56] XCalibre Communications' FlexiScale on-demand utility computing platform experienced another big outage in late October. The outage lasted approximately 18 hours and was reportedly due to near-simultaneous failures in the switches that connect the storage to the processing nodes.[57] Google's Gmail service continued to have problems in the fourth quarter, experiencing an outage starting on October 15 that lasted approximately 30 hours.[58] Some additional availability issues impacting Gmail reportedly also occurred on Monday, October 20.[59]

Problems dealing with "flash crowd" traffic also caused outages at a number of Web sites during the fourth quarter. The Openoffice.org site crashed on October 14, due to overwhelming demand for its new 3.0 software release.[60] The Europeana digital library enjoyed a high-profile launch on November 20, but the system was swamped by an unexpected 10 million user requests per hour and crashed within 24 hours of its launch.[61] The Web site for Dr. Pepper was unavailable for large parts of the day on November 23, as the result of a surge of traffic related to a one-day marketing promotion that promised everyone in America a free bottle of soda if the new Guns n' Roses album was released during 2008. Dr. Pepper ultimately elected to extend the offer an extra day and add more server capacity to handle the load.[62] Web sites can leverage the on-demand capacity available through Akamai's site delivery services to help them avoid traffic-related site downtime or the need to add additional server capacity.

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Section 3: Networks and Web Sites: Issues & Improvements (cont'd)

High traffic levels and application problems combined to take various U.S. Postal Service Web-based services offline the week of December 8. Several different online tools, including the Postal Service's popular Click-N-Ship service, suffered outages.[63] Most tools were available again by Monday afternoon, but the Click-N-Ship service was not fully functional again until Friday, December 12.[64]

A number of social networking and related sites experienced varying amounts of downtime in the fourth quarter. The blog search engine Technorati experienced both downtime and slower performance for more than nine hours on December 12 and 13.[65] Dating website Match.com experienced technical difficulties and was unavailable for more than an hour and a half on October 29.[66] Business networking site LinkedIn was down for over an hour on October 10,[67] and experienced an additional hour-long outage on November 16.[68] Hosted blogging service Typepad was down for an hour on October 3,[69] and micro-blogging service Twitter experienced a brief outage on November 13, lasting just under an hour, due to a DNS configuration error.[70] Popular blogging/social networking site LiveJournal was unavailable for nearly three hours on November 18 while it migrated to a new server facility.[71] A "catastrophic" UPS failure caused a power outage on November 13 at a Santa Clara data center operated by Quality Technology Services, triggering days of performance problems for the social network Friendster. Although the hosting facility was back on generator power within two hours, Friendster remained offline for more than 23 hours over a three day period.[72]

Looking back across all of 2008, Pingdom published[73] a report entitled "Social Network Downtime in 2008," which analyzed the Web site availability (uptime) of 15 of the world's largest social networks. Pingdom noted that Facebook and MySpace, the two largest social networks monitored, both had very little downtime in 2008. Only four social networks that were monitored for the full year achieved overall uptime of 99.9% or better: Facebook (99.92%), MySpace (99.94%), Classmates.com (99.95%), and Xanga (99.95%). Figure 8 illustrates the aggregate downtime (in hours) that Pingdom observed for the social networks that it was monitoring.

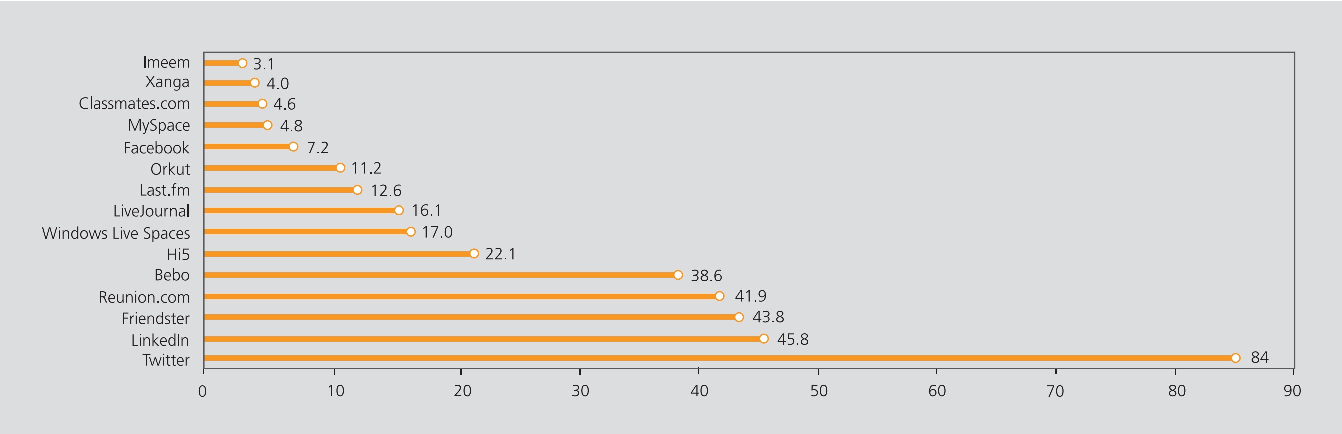


Figure 8: Social Network Downtime in 2008, in hours (Data courtesy of Pingdom)

3.5 Significant New Connectivity — Undersea Cables

A report published in December by telecommunications research firm Telegeography noted[74] that rapid growth in Internet capacity around the world over the last decade has led to a diminished role for the United States as an Internet hub, with dramatic shifts in the amount of traffic that passes through the United States from other continents. Telegeography found that in 1999, 91% of data from Asia passed through the United States at some point on its journey, but by 2008, that had fallen to just 54%. In 1999, 70% of data from Africa passed through the United States, but by 2008, that number decreased to just 6%. One key reason for this decline has been the growth in inter-regional connectivity made possible by numerous submarine cable projects, including those covered in previous editions of Akamai's quarterly *State of the Internet* reports.

In the Middle East, the Cyprus Telecommunications Authority (Cyta) and the Syrian Telecommunication Establishment (STE) have agreed[75] to upgrade the UGARIT submarine cable link between Tartous in Syria and Pentaskhinos in Cyprus in order to increase Internet capacity between the two countries. The 239km UGARIT cable began operations in 1995, and its transmission capacity is limited to 622 Mbps, which is also driving the two companies to initiate feasibility studies for establishing a second submarine link between their countries.

3.6 Significant New Connectivity — Wireless

Representing possibly the extreme in "wireless" Internet connections, in November 2008, NASA reported the first successful tests of its Deep Space Network, which is modeled after the Earth-bound Internet.[76] The Deep Space Network relies upon Disruption-Tolerant Networking (DTN) that does not assume a continuous end-to-end connection — if a link is lost, the communication node will store the information until the connection is re-established.

Closer to Earth, O3b Networks continues to sign contracts to bring Internet connectivity to remote regions using satellites in equatorial orbit. In December 2008, O3b announced that Afghani telco Neda Telecommunications will deploy its Quick Start service as a means for connecting to the Internet, though service activation is not expected until late 2010.[77] In Libya, users working or located in remote areas now have access to satellite-based connectivity through portable satellite broadband terminals, with speeds up to 444 Kbps.[78] Finally, in December, California-based Viasat announced a plan to put a broadband Internet satellite into orbit above the U.S. in the first half of 2011.[79] According to Viasat, the satellite will have an overall throughput of 100 Gbps, which it claims should enable it to support 2 Mbps service to approximately 2 million subscribers when operational. Viasat's plans parallel an effort by Eutelsat in Europe to launch a high capacity broadband satellite in 2010.

Akamai's *3rd Quarter, 2008 State of the Internet* report noted that Sprint-Nextel had launched the "Xohm"-branded WiMAX service in Baltimore, Maryland. During the fourth quarter, Sprint-Nextel completed the formation of a WiMAX joint venture with Clearwire, and re-branded the service as "Clear".[80] The first city expected to get the new "Clear" WiMAX service is Portland, Oregon in early January 2009.[81]

Internationally, announcements of new WiMAX networks surged in the fourth quarter of 2008. During the quarter, Telegeography's CommsUpdate daily briefings[82] highlighted announcements of new or expanded WiMAX networks in Australia,[83] Bahrain,[84] Barbados,[85] Bermuda,[86] Brazil,[87]

Cameroon,[88] Iraq,[89] Italy,[90] Jordan,[91] Kenya,[92,93] Malaysia,[94] Montenegro,[95] Netherlands,[96] Pakistan,[97] Romania,[98] South Africa,[99] Spain,[100] and Sri Lanka.[101]

Telegeography also highlighted the launch of 3G-based mobile broadband services in Canada,[102] Japan,[103] the United Kingdom,[104] and Uzbekistan.[105]

3.7 Significant New Connectivity — Fixed Broadband

The launch of DOCSIS 3.0 is enabling cable providers to roll out higher-speed connectivity options to their customers, with Comcast[106] announcing availability of service tiers up to 50 Mbps in multiple cities across the United States; Virgin Media[107] in the United Kingdom launching a 50 Mbps service; and UPC Netherlands[108] offering access at speeds of 60-120 Mbps.

A number of announcements were also made regarding fiber-to-the-home (FTTH) initiatives in several countries. In Switzerland, Swisscom began to connect households to the neighborhood fiber-optic nodes they had previously deployed.[109] In an interesting move, Swisscom will be laying several fibers per household to enable invited partners in the telecommunications, cable, and utilities industries to expand their own fiber-optic infrastructure. One fiber will be used by Swisscom, while the others will be made available to the potential partners. In November, Netherlands telco KPN and FTTH operator Reggefiber said that they are planning to roll out a FTTH network that could cost as much as 7 billion euros that is planned to cover pretty much every part of the Netherlands.[110] Additional FTTH service announcements were made by Brasil Telecom (Brazil),[111] MTNL (India),[112] Telefonica (Spain),[113] Telecom Italia (Italy),[114] and TTK (Russia).[115]

Also in the fourth quarter, the notion of "homes with tails" began to take root, popularized in a New America Foundation whitepaper[116] published in November. According to the paper, the idea is that "Consumers may one day purchase and own fiber connections that run from their homes. They would then be able to connect to a variety of service providers, including today's Internet, television, and telephone services, as well as ultra-bandwidth intensive services of the future." The paper's authors also propose that the fiber would form part of the property right in the home. However, they note that no market for consumer purchase of fiber currently exists, but they are looking at one trial that is already ongoing in Ottawa, Canada as a means to test their model's feasibility and identify associated challenges and insights.

Also in Canada, the Saskatchewan government announced in late November that they aim to have 100% broadband coverage across the Canadian territory within three years under a new CAD $129 million infrastructure rollout plan. Regional incumbent telecom SaskTel's fixed broadband network footprint will be expanded to cover 100% of the population, up from 86% coverage today, through an expansion of the existing CommunityNet high speed network, upgraded rural backbone infrastructure, and a partnership with a satellite firm in order to provide access to the most remote areas.[117]

Similarly, in November, Finland's government said[118] that it will invest up to €66 million ($85.2 million) as part of plans to increase high speed broadband coverage across the country. The investment is part of an effort to increase access to 100 Mbps connectivity in Finland to 100% of the population by 2016. The expectation is that by 2015, approximately 95% of the population will have access to the higher broadband speeds through commercial development, and by 2010 all broadband users are expected to be able to receive at least 1 Mbps. In France, the government called on telecommunications providers[119] to offer broadband services across all its territory for a maximum of €35 ($45.15) a month. This makes France the first country in the European Union to effectively mandate the supply of broadband services. France Telecom and SFR plan to include broadband among their universal services by the end of 2009.

In the United States, an economic stimulus bill signed in February 2009 reportedly provides $7.2 billion devoted to broadband funding, aimed at creating incentives for additional infrastructure buildout and the development of a comprehensive national broadband plan by the FCC.[120] This "broadband stimulus" will be examined in more detail in Akamai's *1st Quarter, 2009 State of the Internet* report.

3.8 DNS Expansion

According to the *Domain Name Industry Brief* report published[121] by VeriSign, 2008 ended with a total of 177 million domain name registrations across all of the Top Level Domains (TLDs), representing 16% growth over the previous year and 2% growth over the third quarter of 2008. More than 10.1 million new domain names were registered across all of the TLDs in the fourth quarter of 2008, reflecting slower growth in new registrations, with a decline of 12% from the third quarter.

As highlighted in the *2nd Quarter, 2008 State of the Internet* report, in October, ICANN published a draft "Applicant Guidebook" for new generic TLDs, and posted it online for review and comment.[122] According to published reports,[123] ICANN would charge groups $185,000 to apply for a generic TLD, with most of the money going toward evaluation of the application. ICANN's plan would open up TLDs to non-English character sets, and seeks to streamline a TLD-creation process that has proven cumbersome in the past.

However, by the end of the comment period in mid-December, the United States Department of Commerce, the Australian government, members of the global business community, and over 200 commenters on the posted proposal expressed significant opposition to ICANN's plan, urging them to "go back to the drawing board and propose a process that results in a responsible expansion of the name space, not merely a duplication of it." [124]

3.9 IPv6

According to published reports, the adoption of IPv6 continued a slow, steady growth into the end of 2008. A blog post[125] at Internet infrastructure news & opinion site CircleID notes that at the end of the year, 4% of autonomous systems on the Internet supported IPv6, up from 2.4% at the beginning of 2008. In addition, the Number Resource Organization (NRO), which is made up of the five Regional Internet Registries (RIRs), announced[126] in early December that the rate of new entrants into the IPv6 routing system has increased by approximately 300 percent over the past two years. Additional IPv6 statistics presented at the RIPE 57 meeting in October were highlighted in another[127] CircleID blog post, including data on IPv6 traffic by country, OS support, access methods, and IPv6-related latency.

However, research presented at the Proceedings of the ACM Internet Measurement Conference, based on what the researchers claim is "the first complete census of the Internet in more than two decades", discovered a surprising number of unused IPv4 addresses and concluded that many will still be unused in two years when IPv4 address space was projected to be exhausted.[128] "There are huge chunks of IP space which are not allocated yet, and also giant swaths which are inefficiently allocated," the researchers noted.

Section 4: Internet Penetration

4.1 Unique IP Addresses Seen By Akamai

Through a globally-deployed server network, and by virtue of the billions of requests for Web content that it services on a daily basis, Akamai has unique visibility into the levels of Internet penetration around the world. In the fourth quarter of 2008, over 400 million unique IP addresses connected to the Akamai network — almost six percent more than in the third quarter, and over 28 percent more than the same quarter a year ago. Similar to the prior two quarters, nearly 30% of those IP addresses came from the United States and approximately 10% came from China.

	Country	Q4 08 Unique IP's	Q4-Q3 Change	YoY Change
-	Global	401,285,817	+5.67%	+28.38%
1	United States	114,123,038	+4.38%	+24.13%
2	China	40,130,543	+6.75%	+33.08%
3	Japan	27,659,076	+0.53%	+13.98%
4	Germany	27,361,610	+5.69%	+35.93%
5	France	18,583,433	+4.31%	+16.82%
6	United Kingdom	17,781,997	+2.76%	+19.04%
7	South Korea	14,606,042	-1.68%	+10.62%
8	Canada	10,467,353	+1.64%	+11.24%
9	Spain	9,496,698	+5.64%	+20.83%
10	Brazil	8,935,698	+1.80%	+38.17%

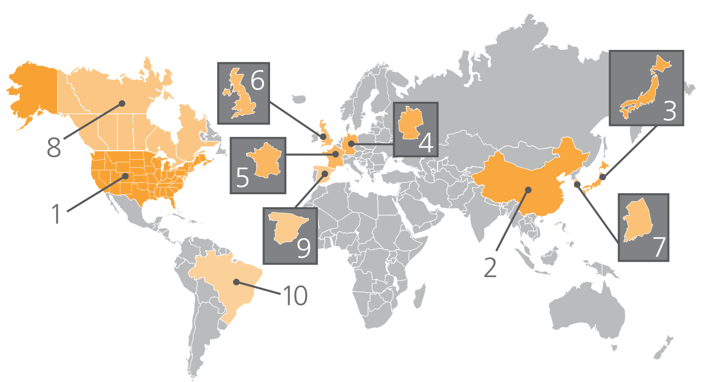


Figure 9: Unique IP Addresses Seen By Akamai

Growth among countries in the Top 10 slowed quarter-over-quarter — in the third quarter, three countries in the Top 10 saw double digit percentage increases, while in the fourth quarter, China was the big gainer at just under seven percent quarterly growth in unique IPs seen by Akamai's network. South Korea also appears to be establishing a quarterly pattern of growth and loss — the country recorded quarterly increases in the first and third quarters of 2008, and quarterly losses in the second and fourth quarters of 2008. For the year, however, South Korea was up over 10%, adding approximately 1.5 million unique IP addresses seen by Akamai.

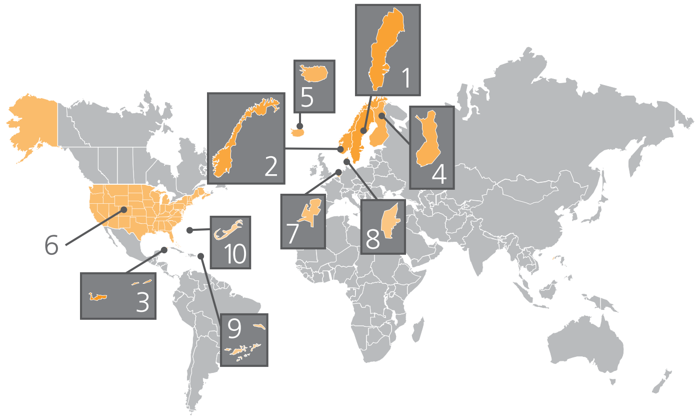
On a global basis, year-over-year, Akamai saw the number of unique IP addresses more than double in 19 countries — Turks and Caicos led the list with 695% growth. (To be fair, this statistic is also influenced by the law of small numbers, as they ended 2008 with just under 2,400 unique IP addresses seen by Akamai.) Sixteen countries had a net loss year-over-year in the number of unique IP addresses seen by Akamai — most are smaller African nations, remote island nations in the Pacific Ocean, or countries in the midst of ongoing civil unrest.

Looking at the "long tail," there were 187 countries with fewer than 1 million unique IP addresses connecting to Akamai in the fourth quarter of 2008, 146 with under 100,000 unique IP addresses, and 38 with fewer than 1,000 unique IP addresses. As compared to the prior two quarters, these country counts remained extremely stable.

4.2 Internet Penetration, Global

How does the number of unique IP addresses seen by Akamai compare to the population of each of those countries? Asked another way, what is the level of Internet penetration in each of those countries? Using 2008 global population data[129] from the United States Census Web site as a baseline, levels of Internet penetration for each country around the world were calculated based on Akamai's view into Internet traffic. The countries in the Top 10 list shown in Figure 10 were stable from quarter-to-quarter, although there was some shifting of positions, as Finland, Iceland, the Cayman Islands, and the British Virgin Islands were all ahead of where they were ranked in the third quarter. Globally, the number of unique IP's per capita grew from 0.06 in the third quarter (and 0.05 in the first quarter) to 0.08 at the end of 2008.

These per capita figures should be considered as an approximation, as the population figures used to calculate them are static estimates — obviously, they will change over time, and it would be nearly impossible to obtain exact numbers on a quarterly basis. In addition, individual users can have multiple IP addresses (handheld, personal/home system, business laptop, etc.). Furthermore, in some cases, multiple individuals may be represented by a single IP address (or small number of IP addresses), as they access the World Wide Web through a firewall proxy server. Akamai believes that it sees approximately 1 billion users per day, though we see only approximately 400 million unique IP addresses.



	Country	Unique IP's Per Capita
-	Global	0.08
1	Sweden	0.46
2	Norway	0.42
3	Cayman Islands	0.40
4	Finland	0.39
5	Iceland	0.39
6	United States	0.38
7	Netherlands	0.36
8	Denmark	0.36
9	British Virgin Islands	0.35
10	Bermuda	0.34

Figure 10: Global Internet Penetration

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Section 4: Internet Penetration (cont'd)

4.3 Internet Penetration, United States

For the second consecutive quarter, Akamai is examining the level of Internet penetration within the United States. Using state population estimates available from the United States Census Web site,[130] and the number of unique IP addresses from each state that Akamai saw during the fourth quarter, we calculated the levels of Internet penetration on a state-by-state basis. The same caveats noted immediately above in section 4.2, regarding per capita figures as an approximation, apply here as well.

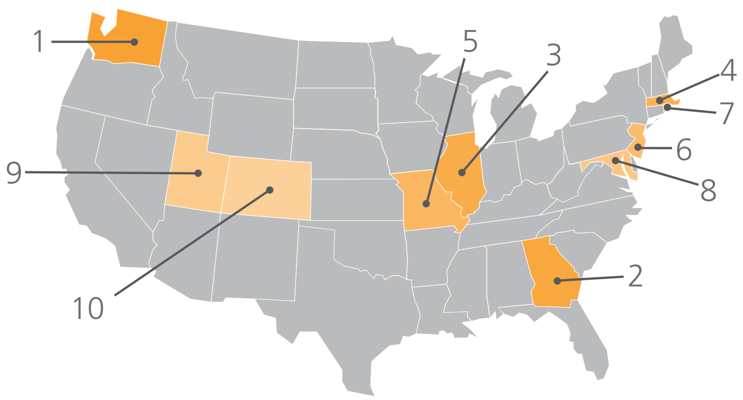


Figure 11: Internet Penetration in the United States

As shown in Figure 11, many states experienced moderate increases in Internet penetration quarter-over-quarter, while it appears that Virginia and New Jersey appear to have experienced significant decreases. It is not clear whether this is the beginning of a longer-term trend for these states, or just a one-time anomaly. Future editions of this report will continue examine ongoing trends in levels of Internet penetration.

	State	Unique IP's Per Capita
1	Washington	0.61
2	Georgia	0.59
3	Illinois	0.55
4	Massachusetts	0.54
5	Missouri	0.50
6	New Jersey	0.47
7	Rhode Island	0.46
8	Maryland	0.46
9	Utah	0.44
10	Colorado	0.41

Section 5: Geography

Through its globally deployed server network and by virtue of the billions of requests for Web content that it services on a daily basis, Akamai has a unique level of visibility into the connection speeds of those systems issuing the requests, and as such, of broadband adoption around the globe. Because Akamai has implemented a distributed network model, deploying servers within edge networks, it can deliver content more reliably and more consistently at those speeds, in contrast to centralized competitors that rely on fewer deployments in large data centers. For more information on why this is possible, please see Akamai's *How Will The Internet Scale?* white paper.[131]

The data presented below was collected during the fourth quarter of 2008 through Akamai's globally-deployed server network and includes all countries and U.S. states that had more than 1,000 average monthly unique IP addresses make requests to Akamai's network during the fourth quarter. For the purposes of classification in this report, the "broadband" data included below is for connections greater than 2 Mbps, and "high broadband" is for connections 5 Mbps or greater. In contrast, the "narrowband" data included below is for connections slower than 256 Kbps. Quarter-over-quarter and year-over-year changes are shown in an effort to highlight general and longer-term trends.

As the quantity of HD-quality media increases over time, and the consumption of that media increases, end users are likely to require ever-increasing amounts of bandwidth. A connection speed of 2 Mbps is arguably sufficient for standard-definition TV-quality video content, and 5 Mbps for standard-definition DVD-quality video content, while Blu-Ray (1080p) video content has a maximum video bit rate of 40 Mbps, according to the Blu-Ray FAQ.[132]

5.1 Average Connection Speeds, Global

This quarter, the *State of the Internet* report will begin tracking average connection speeds for countries around the world. While quarterly variances are likely, we expect that over the long term, the overall trend will be towards higher average connection speeds as levels of broadband adoption continue to grow. Current highlights and historical trends for average connection speeds on a global basis can be found in Akamai's new data visualization tool, available at *http://www.akamai.com/dv5*.

Globally, the average connection speed was approximately 1.5 Mbps — the speed of a T-1 Internet connection. Looking at the top 10 globally, South Korea ranks first with average connection speed of 15 Mbps — 10x the global average. As has been discussed previously, with regard to the adoption of high broadband Internet connections, Asia and Northern Europe hold the majority of the spots in the top 10, as shown in Figure 12.

The United States ranked 17th globally, with an average connection speed of 3.9 Mbps, up approximately 8% from the average connection speed for the first quarter of 2008. We expect that this average speed will continue to grow over time, as new technologies, such as DOCSIS 3.0 (as described in Section 3.7) enable consumer broadband connections to reach significantly higher speeds.

5.2 Average Connection Speeds, United States

In December, PCMag.com published an article titled "The Fastest ISPs in America — and Where You Live."[133] Leveraging their own SurfSpeed application ("a utility that grabs pages and page elements from several popular Web sites to measure actual Internet surfing speed"), PCMag collected data points from more than 17,000 unique IP addresses, comprising over 200,000 individual tests, and then analyzed the results to find the fastest ISPs in the United States, as well as ranking each state on average download speed. In addition, The Communications

	Country	Q4 08 Mbps
-	Global	1.5
1	South Korea	15.0
2	Japan	7.0
3	Hong Kong	6.9
4	Romania	5.7
5	Sweden	5.6
6	Switzerland	5.1
7	Netherlands	4.9
8	Belgium	4.7
9	Slovakia	4.5
10	Norway	4.5
...		
17	United States	3.9

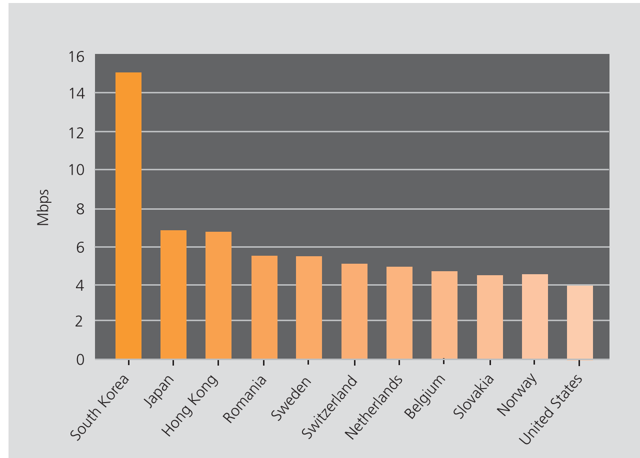


Figure 12: Average Internet Connection Speed by Country

Workers of America (CWA) published a report in August 2008 titled *"A Report on Internet Speeds in All 50 States"*[134] that included median speeds as calculated from nearly 230,000 people who took a speed test at the speedmatters.org Web site between May 2007 and May 2008.

Based on the billions of requests for Web content that Akamai services on a daily basis, we are also able to calculate the average connection speeds of users across the United States. Looking back over all of 2008, most states saw nominal to significant increases in their average broadband speed, with both Nebraska and Kentucky seeing a 33% improvement from the first quarter to the fourth quarter. Several states, including Rhode Island and New Jersey, saw minor decreases over the course of the year.

Interestingly, the data aggregated and analyzed by Akamai in the fourth quarter diverges significantly from that presented in the PCMag article, and more nominally from that presented in the CWA paper. For all states, Akamai's average observed connection speeds were significantly higher than those calculated by PCMag — they diverged by a factor of anywhere between 4.1x (Illinois) and 13.2x (Vermont). Akamai's full data set, and a comparison to the data from the PCMag and CWA studies is shown in Figure 13.

There are several likely reasons for the divergence in observed connection speeds. One possible explanation is the vast difference in sample sizes — the PCMag study encompassed data from only 17,000 unique IP addresses, and the CWA study from 230,000, while Akamai's study included data from more than 100 million unique IP addresses. Another possible explanation is that PCMag's study collected data only from computers connected to consumer ISPs — that is, home computers, whereas Akamai's collects data from computers connected to both consumer and commercial Internet connections — the latter are most frequently much faster. The CWA paper notes "Most people who went to speedmatters.org to take the speed test used a DSL connection, a cable modem, or a fiber connection." While not explicitly stated, it may be inferred that their users were also likely on consumer ISP connections. However, it's not clear that these possible explanations account for differences that exceed an order of magnitude in some cases.

AKAMAI RANK	STATE	AKAMAI Q4 08 AVERAGE (KBPS)	PCMAG SURFSPEED (KBPS)	CWA MEDIAN (KBPS)
1	Delaware	7280	646	6685
2	New Hampshire	6088	615	2877
3	Connecticut	5425	716	2888
4	New York	5373	714	4142
5	Rhode Island	5334	516	6769
6	Nevada	5191	781	2815
7	Vermont	5172	391	1890
8	Oklahoma	5111	695	1856
9	Maine	5074	427	2558
10	Utah	5008	517	2324
11	Indiana	4924	524	2301
12	Massachusetts	4882	695	4564
13	Wisconsin	4495	402	2372
14	Oregon	4399	665	2624
15	California	4361	666	2470
16	Nebraska	4354	707	2032
17	Tennessee	4313	474	2755
18	Virginia	4295	765	5033
19	Kentucky	4252	547	1795
20	Pennsylvania	4177	747	2396
21	South Carolina	4141	457	2849
22	Michigan	4023	544	2573
23	Minnesota	3955	609	1566
24	Ohio	3953	600	2523
25	North Carolina	3925	534	2925
26	Colorado	3831	564	2341
27	Florida	3792	562	3988
28	West Virginia	3761	417	1987
29	New Mexico	3734	322	2003
30	Maryland	3718	691	3981
31	Iowa	3713	398	1455
32	Arizona	3632	505	2172
33	Alabama	3626	556	2213
34	North Dakota	3565	593	1164
35	Louisiana	3448	470	2706
36	New Jersey	3426	727	5825
37	Washington	3396	625	3016
38	Kansas	3366	528	2466
39	Mississippi	3348	413	1567
40	South Dakota	3171	560	2222
41	Texas	3158	605	2526
42	Hawaii	3114	378	1675
43	Georgia	3061	679	3041
44	Wyoming	2972	379	1325
45	Arkansas	2897	402	1342
46	Illinois	2801	681	2522
47	Idaho	2776	461	1326
48	Montana	2603	455	1320
49	Missouri	2422	539	1881
50	Alaska	2000	402	814

Figure 13: Measured Connection Speed by State

Country	% above 5 Mbps	Q4–Q3 Change	YoY Change
- Global	19%	-0.1%	+21%
1 South Korea	69%	+20%	+7.3%
2 Japan	54%	+2.3%	+21%
3 Romania	45%	+4.5%	+124%
4 Sweden	39%	+3.6%	+25%
5 Hong Kong	38%	+0.2%	+0.3%
6 Belgium	31%	+7.4%	+91%
7 Netherlands	28%	+9.8%	+34%
8 Denmark	27%	+0.9%	+128%
9 United States	25%	-3.9%	+27%
10 Latvia	23%	-4.0%	+65%

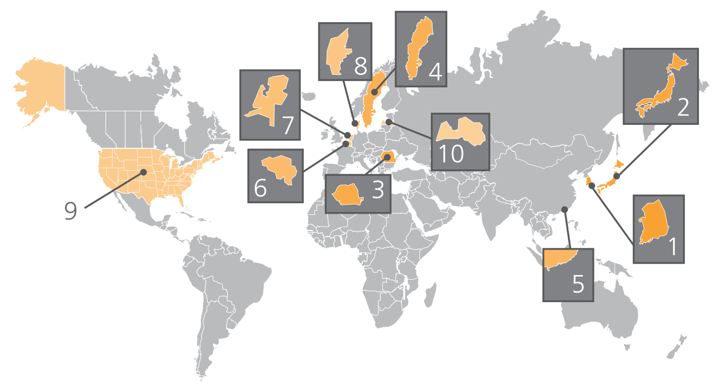


Figure 14: High Broadband Connectivity, Fastest International Countries

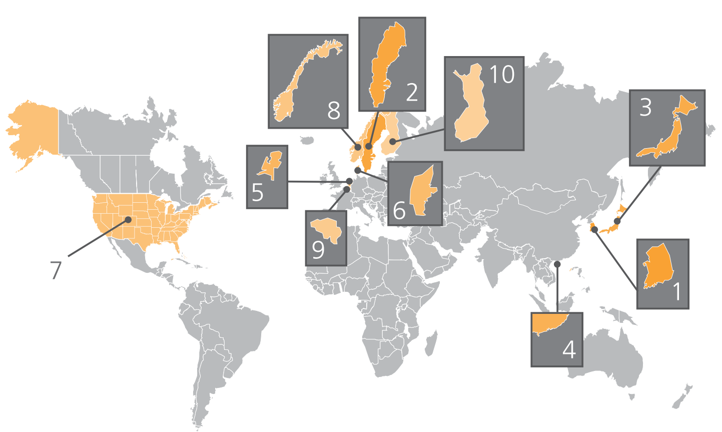
5.3 High Broadband Connectivity: Fastest International Countries

At the end of 2008, approximately 19% of Internet connections around the world were at speeds greater than 5 Mbps. Based on historical data collected by Akamai, this level remained generally consistent over the last three quarters of 2008, and represents a 21% increase over the average global connection speed at the end of 2007.

In line with their average connection speed of 15 Mbps, and their appearance at the top of the list for the prior three quarters, South Korea once again ranked as the country with the highest percentage of connections at high broadband (>5 Mbps) speeds. Over the course of 2008, South Korea's rate of quarterly change appeared to be locked into a cyclical pattern, with quarterly decreases being recorded in the first and third quarters, and increases seen in the second and fourth quarters. For the whole year, South Korea saw a modest 7% increase in their levels of high broadband adoption.

In the fourth quarter, the United States saw a minor decline in the percentage of connections to Akamai at speeds above 5 Mbps, though the level of high broadband adoption was up 27% for the year. It's not clear what caused the decline in Q4, although published reports[135] indicate that many consumers, in order to save money, would scale down their broadband service (to a lower speed tier), rather than cancelling it outright.

Looking at the levels of high broadband penetration in the fourth quarter, as shown in Figure 15, South Korea, Sweden, the Netherlands, Denmark, and Norway had more high broadband IP's per capita than in the prior quarter. This is consistent with what would be expected from the initiatives to bring higher speed connectivity, including FTTH efforts, to consumers in these countries, as reported in Section 3.7 above, as well as in previous issues of Akamai's *State of the Internet* report.



Country	High Broadband IP's Per Capita
- Global	0.01
1 South Korea	0.21
2 Sweden	0.18
3 Japan	0.12
4 Hong Kong	0.10
5 Netherlands	0.10
6 Denmark	0.10
7 United States	0.09
8 Norway	0.09
9 Belgium	0.07
10 Finland	0.07

Figure 15: Global High Broadband Penetration

State	% above 5 Mbps	Q4–Q3 Change	YoY Change
1 Delaware	62%	+8.9%	+5.6%
2 New Hampshire	56%	-6.1%	+88%
3 New York	46%	-2.2%	+29%
4 Vermont	42%	-9.1%	+126%
5 Connecticut	42%	-3.7%	+26%
6 Rhode Island	40%	-15%	-8.3%
7 Nevada	39%	+6.7%	+14%
8 Maine	39%	+19%	+353%
9 Massachusetts	37%	-3.5%	+26%
10 Oklahoma	35%	+1.1%	+9.6%

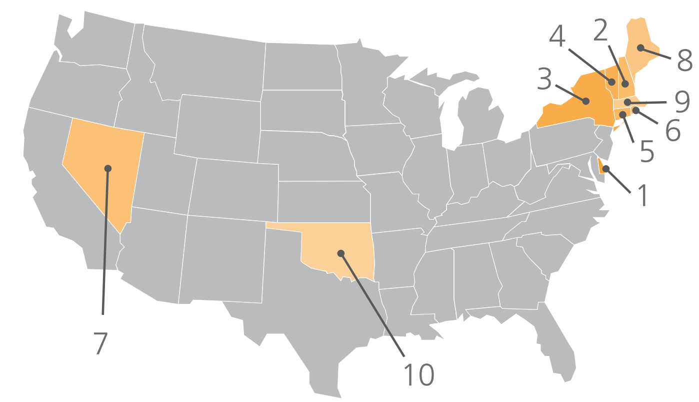


Figure 16: High Broadband Connectivity, Fastest U.S. States

5.4 High Broadband Connectivity: Fastest U.S. States

Maintaining the trend from the prior three quarters of 2008, the East Coast of the United States was once again very well represented in the Top 10 list of U.S. states with the greatest levels of high broadband (>5 Mbps) connectivity, taking eight of the top 10 slots, as shown in Figure 16. Interestingly, six of the states in the Top 10 showed quarterly declines in the percentage of connections to Akamai at speeds over 5 Mbps. Looking back across all of 2008, Rhode Island was the only state in the Top 10 to see a decline year-over-year. Elsewhere, North Dakota, Illinois, Kansas, Arizona, Alaska, and Missouri also saw percentages drop year-over-year.

State	YoY Change
Maine	+353%
Florida	+153%
Vermont	+126%
Oregon	+125%
Kentucky	+118%
Hawaii	+117%
New Mexico	+103%

Figure 17: Greatest Year-Over-Year Increases in High Broadband Connectivity

State	High Broadband IP's Per Capita
1 Massachusetts	0.20
2 New York	0.19
3 Rhode Island	0.19
4 Washington	0.15
5 New Hampshire	0.13
6 Maryland	0.13
7 New Jersey	0.13
8 Oregon	0.13
9 Connecticut	0.12
10 Nevada	0.12

Figure 18: High Broadband Penetration in the United States

Section 5: Geography (continued)

Comparing the states listed in Figure 16 to the list of states in Figure 13 that have average measured connection speeds above 5 Mbps, Utah is the only state not listed in the High Broadband Top 10. Akamai's measurements rank Utah 29th, with 23% of connections to Akamai at high broadband levels.

As shown in Figure 17, seven states more than doubled their percentage of high broadband connectivity during 2008, with Maine seeing a remarkable level of growth — over 300%. An additional eleven states saw gains in excess of 50% year-over-year.

Looking at high broadband penetration across the United States, we see in Figure 18 that seven of the Top 10 states are on the East Coast, down from eight in the third quarter. Quarterly change was mixed, as six states (New York, Washington, Maryland, Oregon, Connecticut, Nevada) saw an increase, two states (Rhode Island and New Jersey) saw a decrease, and two states (Massachusetts and New Hampshire) saw flat levels of high broadband penetration.

5.5 Broadband Connectivity: Fast International Countries

Internationally, the percentage of connections to Akamai at speeds greater than 2 Mbps continues to be more clustered than the "high broadband" data, with only 12% separating No. 1 Tunisia (96%) and No. 10 Germany (84%) — the gap was 20% in the first quarter of 2008, 15% in the second quarter of 2008, and 13% in the third quarter of 2008. The United States dropped further down the list from the third quarter, to No. 35, seeing a further 1.7% loss from the third quarter. Overall, all of the countries in the Top 10 saw year-over-year increases in broadband adoption, while the United States saw a nominal decrease year-over-year, as shown in Figure 19. Of the countries in the Top 10, Tunisia saw the greatest increase at 56%, vaulting into the Top 10 in the third quarter. Monaco, Denmark, and Germany also saw increases in excess of 20%.

Rounding out the year, European countries continued to demonstrate some of the highest levels of broadband penetration, holding eight of the Top 10 slots, as seen in Figure 20. The United States recorded a slight increase, and continued to maintain the 11th place position.

	Country	% above 2 Mbps	Q4–Q3 Change	YoY Change
–	Global	57%	-0.5%	+2.1%
1	Tunisia	96%	-0.5%	+56%
2	South Korea	94%	+2.0%	+2.5%
3	Belgium	93%	+0.9%	+7.8%
4	Switzerland	92%	+0.7%	+5.7%
5	Japan	90%	-1.3%	+7.8%
6	Hong Kong	88%	+0.5%	+1.7%
7	Monaco	86%	-0.5%	+36%
8	Slovakia	85%	-2.5%	+13%
9	Denmark	85%	+1.0%	+24%
10	Germany	84%	+1.9%	+23%
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35	United States	63%	-1.7%	-1.6%

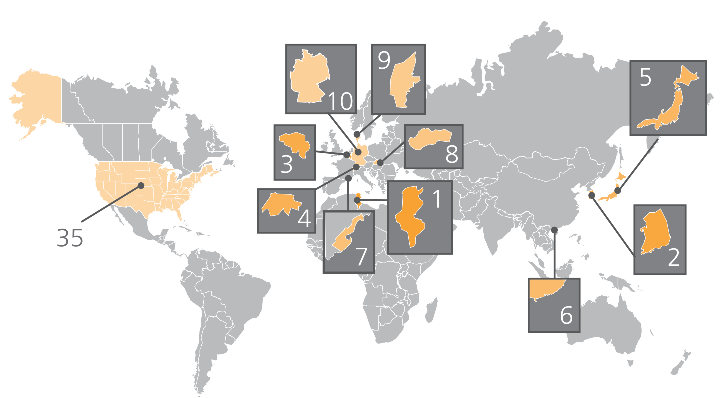


Figure 19: Broadband Connectivity, Fast International Countries

	Country	Broadband IP's Per Capita
-	Global	0.04
1	Sweden	0.36
2	Norway	0.33
3	Iceland	0.32
4	Denmark	0.31
5	Netherlands	0.29
6	South Korea	0.28
7	Germany	0.28
8	Switzerland	0.27
9	Monaco	0.27
10	Hong Kong	0.24
…		
11	United States	0.24

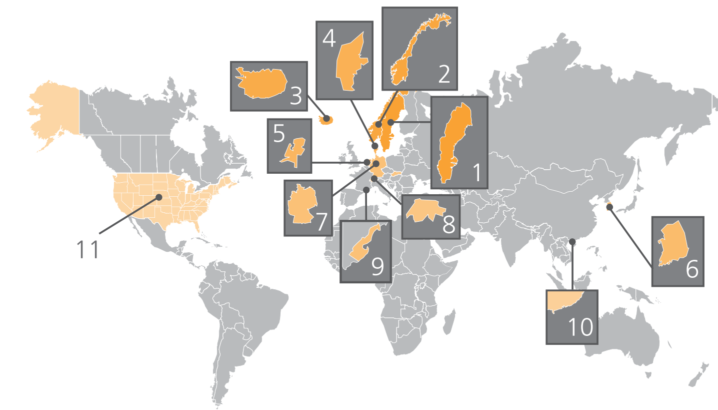
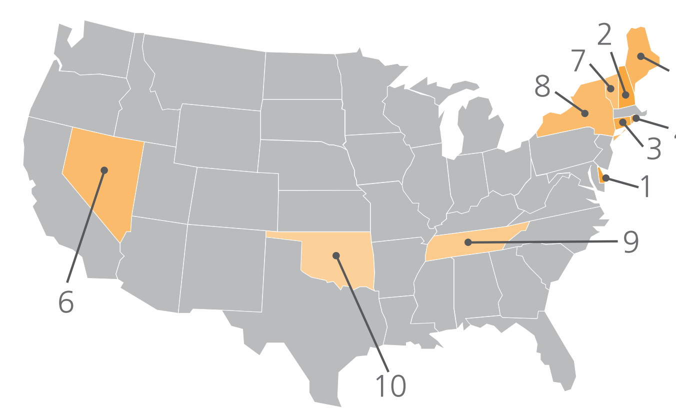


Figure 20: Global Broadband Penetration

From a global perspective, penetration effectively quadrupled during 2008, from 0.01 broadband IP's per capita in the first quarter to 0.04 in the fourth quarter.

5.6 Broadband Connectivity: Fast U.S. States

Akamai data indicates that the fourth quarter of 2008 saw eight of the Top 10 states recording a quarterly increase in broadband penetration, as shown in Figure 21. Year-over-year, all of the states in the Top 10 saw an increase, while across the whole country, 11 states (North Carolina, North Dakota, Utah, Michigan, Georgia, Texas, New Jersey, Illinois, Washington, Maryland, and Missouri) saw a decline. Missouri lost the most broadband penetration in 2008, declining nearly 30%, while North Carolina lost the least, with a 1.0% decline over the course of the year. (One possible explanation for some of the more significant losses is that a large number of connections may have been just above the 2 Mbps threshold — that is, an average speed decrease of just a few Kbps would remove them from being classified as "broadband".)



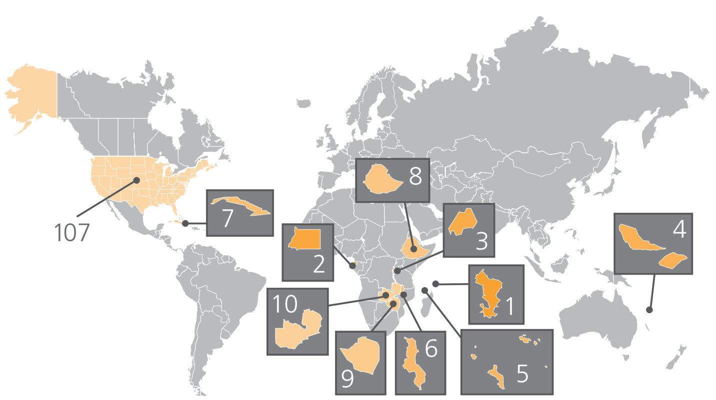
	State	% above 2 Mbps	Q4–Q3 Change	YoY Change
1	Delaware	97%	+0.4%	+1.9%
2	New Hampshire	89%	+0.8%	+23%
3	Connecticut	88%	+1.1%	+7.5%
4	Rhode Island	87%	+0.8%	+4.9%
5	Maine	86%	+1.7%	+22%
6	Nevada	85%	+0.7%	+1.5%
7	Vermont	82%	+0.3%	+40%
8	New York	81%	-0.5%	+7.0%
9	Tennessee	81%	+0.4%	+11%
10	Oklahoma	80%	-0.1%	+2.9%

Figure 21: Broadband Connectivity, Fast U.S. States

5.7 Narrowband Connectivity: Slowest International Countries

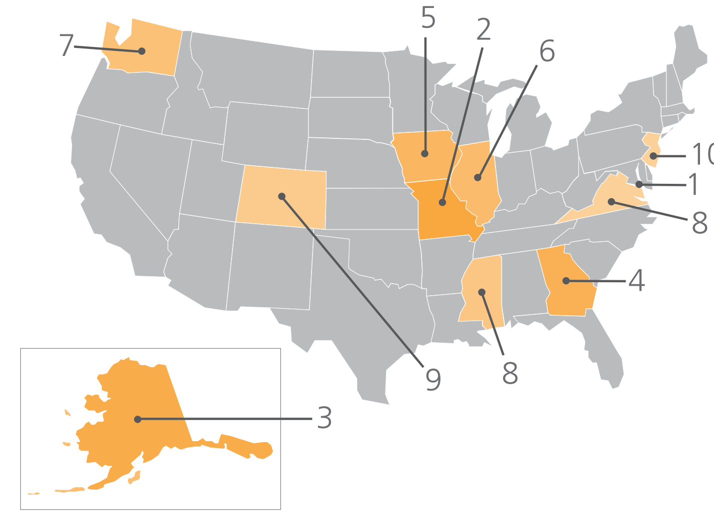
While broadband adoption continues to increase in many countries across the world, many other countries are still stuck with low-speed Internet connections, with large percentages of their connections to Akamai occurring at speeds below 256 Kbps.

Similar to the prior three quarters, many of the countries with the largest percentages of connections to Akamai at speeds below 256 Kbps were either island nations or on the African continent. Unfortunately, out of the Top 10 countries listed in Figure 22, only Malawi and Ethiopia saw quarterly decreases in levels of narrowband penetration, and extremely minor decreases at that. The United States fell one spot to No. 107, and saw a 17% decrease in narrowband penetration quarter-over-quarter, and a 36% decline year-over-year. For the nine countries that ended 2008 with over 90% narrowband penetration, seven of them saw their percentages increase from where they ended 2007. While this is likely indicative of generally increased connectivity, it is clear that Internet users in these countries are unlikely to be consuming HD-quality video any time in the near future. (For the fourth quarter, Mayotte and Cuba both had average connection speeds below 100 Kbps, while connections from the other eight countries in the Top 10 averaged between 100-200 Kbps.)



	Country	% below 256 Kbps	Q4–Q3 Change	YoY Change
–	Global	4.9%	-1.4%	-43%
1	Mayotte	98%	+1.4%	+25%
2	Equatorial Guinea	96%	+2.0%	+64%
3	Rwanda	96%	+3.5%	-0.5%
4	Wallis & Futuna	95%	+6.1%	+54%
5	Seychelles	94%	+1.5%	+24%
6	Malawi	93%	-0.1%	+6.1%
7	Cuba	93%	+1.7%	+3.0%
8	Ethiopia	93%	-0.8%	-1.3%
9	Zimbabwe	92%	+16%	+6.1%
10	Zambia	89%	+3.0%	+5.1%
	…			
107	United States	4.8%	-17%	-36%

Figure 22: Narrowband Connectivity: Slowest International Countries



	Country	% below 256 Kbps	Q4–Q3 Change	YoY Change
1	District of Columbia	9.3%	-6.8%	-42%
2	Missouri	8.2%	-4.2%	+7.3%
3	Alaska	8.2%	-14%	-33%
4	Georgia	7.3%	-29%	-46%
5	Iowa	7.3%	-13%	-30%
6	Illinois	6.8%	-41%	-50%
7	Washington	6.7%	-50%	-18%
8	Mississippi	6.7%	-4.1%	-11%
9	Colorado	6.7%	-8.6%	-20%
10	New Jersey	6.4%	-15%	-3.0%

Figure 23: Narrowband Connectivity: Slowest U.S. States

5.8 Narrowband Connectivity: Slowest U.S. States

The District of Columbia continued to have the highest percentage of narrowband connections in the fourth quarter as observed by Akamai, though the percentage is trending in the right direction, with a nearly seven percent quarterly decline. All of the states in the Narrowband Top 10 demonstrated quarterly declines, with Washington and Illinois declining over 40%, and Georgia declining nearly 30%, as shown in Figure 23.

Missouri stood alone as the only state in the Top 10 to show an increase in narrowband penetration year-over-year, and in fact, was one of only two states in the country to do so. (The other state was Utah, with a surprising 30% increase.) Overall, twenty-four states demonstrated four consecutive quarters of declining narrowband penetration.

Seven states saw a greater than 50% decline in their narrowband connections during 2008, as shown in Figure 24. An additional eight states saw narrowband penetration decline in excess of 40%, and only two states (New Jersey and Michigan) saw declines below 10%.

State	YoY Change
Virginia	-89%
West Virginia	-60%
Nevada	-57%
Texas	-56%
Delaware	-54%
Nebraska	-52%
Rhode Island	-51%

Figure 24: Greatest Year-Over-Year Decreases in Narrowband Connectivity

Section 6: Appendix

REGION	% ATTACK TRAFFIC	UNIQUE IP ADDRESSES	UNIQUE IPs PER CAPITA	AVG SPEED (KBPS)	% ABOVE 5 MBPS	HIGH BB IPs PER CAPITA	% ABOVE 2 MBPS	BB IPs PER CAPITA	% BELOW 256 KBPS
Europe									
Austria	0.23%	1,724,481	0.21	3773	18%	0.04	72%	0.15	1.6%
Belgium	0.14%	2,518,468	0.24	4737	31%	0.07	93%	0.22	0.8%
Czech Republic	0.27%	1,369,307	0.13	4381	22%	0.03	72%	0.10	2.5%
Denmark	1.15%	1,996,751	0.36	4451	27%	0.10	85%	0.31	1.0%
Finland	0.18%	2,070,917	0.39	3260	17%	0.07	53%	0.21	1.0%
France	1.42%	18,583,433	0.29	3206	6.9%	0.02	77%	0.22	0.8%
Germany	2.15%	27,361,610	0.33	3766	15%	0.05	84%	0.28	1.5%
Greece	0.21%	1,255,195	0.12	2841	8.4%	0.01	52%	0.06	4.5%
Iceland	0.01%	119,450	0.39	4124	15%	0.06	80%	0.32	1.5%
Ireland	0.07%	983,385	0.24	3869	10%	0.02	53%	0.13	4.1%
Italy	1.28%	7,088,162	0.12	2974	5.9%	0.01	74%	0.09	3.2%
Luxembourg	0.03%	142,820	0.29	2497	3.9%	0.01	64%	0.19	3.3%
Netherlands	0.44%	6,067,302	0.36	4853	28%	0.10	79%	0.29	1.4%
Norway	0.12%	1,929,774	0.42	4481	21%	0.09	79%	0.33	1.1%
Portugal	0.25%	1,524,819	0.14	3227	14%	0.02	74%	0.11	1.6%
Spain	1.48%	9,496,698	0.23	2624	2.8%	0.01	67%	0.16	1.6%
Sweden	10.7%	4,122,759	0.46	5585	39%	0.18	78%	0.36	2.3%
Switzerland	0.31%	2,252,071	0.30	5055	22%	0.07	92%	0.27	1.7%
United Kingdom	1.45%	17,781,997	0.29	3492	8.0%	0.02	81%	0.23	1.6%
Asia/Pacific									
Australia	0.36%	6,587,018	0.31	2499	9.2%	0.03	49%	0.15	6.0%
China	19.3%	40,130,543	0.03	833	0.6%	<0.01	4.1%	<0.01	9.2%
Hong Kong	0.49%	1,911,645	0.27	6928	38%	0.10	88%	0.24	1.3%
India	1.16%	2,629,923	<0.01	772	0.6%	<0.01	3.7%	<0.01	26%
Japan	2.00%	27,659,076	0.22	7037	54%	0.12	90%	0.20	2.0%
Malaysia	0.40%	882,866	0.03	1037	0.9%	<0.01	4.3%	<0.01	17%
New Zealand	0.46%	1,059,583	0.25	2717	5.0%	0.01	64%	0.16	7.7%
Singapore	0.42%	777,620	0.17	3818	22%	0.04	80%	0.14	1.1%
South Korea	2.52%	14,606,042	0.30	15239	69%	0.21	94%	0.28	0.2%
Taiwan	5.61%	4,653,279	0.20	4146	14%	0.03	51%	0.10	1.6%
Middle East									
Egypt	0.20%	590,249	0.01	489	0.1%	<0.01	1%	<0.01	23%
Israel	0.31%	1,462,693	0.21	2868	4.3%	0.01	56%	0.12	0.5%
Kuwait	0.06%	130,429	0.05	1894	5.2%	<0.01	33%	0.02	7.9%
Saudi Arabia	0.09%	528,906	0.02	1604	3.3%	<0.01	20%	<0.01	7.5%
Sudan	0.01%	13,275	<0.01	354	<0.1%	<0.01	0.3%	<0.01	29%
Syria	<0.01%	34,296	<0.01	304	0.2%	<0.01	2.2%	<0.01	73%
United Arab Emirates (UAE)	0.15%	383,524	0.08	1379	3.3%	<0.01	17%	0.01	11%
Latin & South America									
Argentina	2.51%	2,435,372	0.06	1313	0.2%	<0.01	15%	0.01	5.5%
Brazil	1.68%	8,935,698	0.05	991	1.0%	<0.01	9.8%	<0.01	20%
Chile	1.03%	1,461,338	0.09	1809	0.7%	<0.01	26%	0.02	1.5%
Colombia	0.95%	1,496,294	0.03	1219	0.3%	<0.01	15%	0.01	5.8%
Mexico	0.73%	5,808,981	0.05	948	0.2%	<0.01	4.5%	<0.01	3.7%
Peru	0.26%	511,638	0.02	824	0.1%	<0.01	2.4%	<0.01	3.8%
Venezuela	0.38%	1,498,563	0.06	825	0.1%	<0.01	1.5%	<0.01	6.3%
North America									
Canada	1.68%	10,467,353	0.32	3786	20%	0.06	74%	0.23	2.7%
United States	22.9%	114,123,038	0.38	3913	25%	0.09	63%	0.24	4.8%

Section 7: Endnotes

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